Using Radioiodine Speciation to Address Environmental Remediation and Waste Stream Sequestration Problems at the Fukushima Daiichi Nuclear Power Plant and a DOE Site

PI: Peter H. Santschi, Texas A&M University Galveston (TAMUG), Galveston TX

Collaborators: Daniel Kaplan, Savannah River National Laboratory, Aiken, SC

Toshihiko Ohnuki, Japan Atomic Energy Agency, 2-4 Shirakata, Tokai, Ibaraki, Japan

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ABSTRACT:

The scope proposed in this U.S. (TAMUG and SRNL) and Japanese (JAEA and Kyushu University) **collaboration** could not be completed by a scientist from either individual country. Unique capabilities from each country will address complementary needs for the overall DOE-EM cleanup mission and accelerated decommissioning of the Fukushima Daiichi Nuclear Power Plant (FDNPP). This proposal focuses on the U.S. scope, while a complimentary Japanese proposal focusing on their scope was submitted to MEXT. ^{129}I is either the top or among the top three risk drivers at DOE Low Level Waste or High Level Waste disposal sites. Additionally, one of the key radionuclides driving uncertainty with the secondary waste generated from ALPS waste water treatment facility at FDNPP. Radioiodine's risk stems largely from its perceived high environmental mobility, large inventory (high fission yield), high toxicity (a thyroid seeker), and long half-life (16M years). ^{129}I exists as multiple species, of which iodide, iodate, and organo-iodine are most common. Significant progress has been made over the last 10 years in understanding radioiodine chemistry in groundwater and waste streams as a result of our breakthrough in iodine species detection. This analytical method can detect stable or radioactive iodine at ambient concentrations using standard laboratory equipment. We have shown at the Savannah River Site, Hanford, and Fukushima, that each iodine species has vastly different chemical properties, including a tendency to remain mobile, to adsorb to solids or coprecipitate. The **hypothesis** of this study is engineering solutions to environmental remediation and waste stream stabilization of radioiodine must be based on knowledge of iodine speciation. This hypothesis is the motivation behind four **objectives** that will be led by the U.S. team and two additional objectives led by the Japanese team. Objective #1: characterize waste stream radioiodine speciation, which will involve measuring radioiodine speciation to provide information that will be used in development of species-specific stabilization technologies. The systems that will be evaluated in this project include cement waste forms, tank simulant (feed for reducing cement waste forms), ALPS waste streams, and Fukushima groundwater. Objective #2: conduct a screening test for low-cost, highly effective sorbent. Objective #3:involve detailed investigations of the most promising strategies identified during the initial screening tests. Also included will be a multi-year field demonstration using a test-bed facility at SRNL's Radionuclide Field Lysimeter Experiment (RadFLEx). Objective #4: development of a model for designing treatment systems. This will be parameterizing using data generated from Objectives #1, #2, and #3. There are two additional objectives related to the accelerated decommissioning of FDNPP that will be led by our Japanese colleagues: 1) enhance radioiodine removal from ALPS waste water and 2) stabilized secondary waste generated from ^{129}I removal steps of the ALPS facility. These two items were identified in Mid-and-Long-Term Roadmap for the Decommissioning of FDNPP. **Expected results** from this research will provide the first measurements of iodine speciation in simulant tank waste, cementitious waste form pore water, ALPS waste streams, and Fukushima groundwater samples (**Deliverable Year 1)**. This data will provide key information needed to design appropriate stabilization technologies for the overall DOE-EM cleanup mission and accelerated decommissioning of FDNPP (**Deliverable Years 2, 3)**. The project will culminate in development of a model that can be used to help design systems to implement proposed technologies, either as sorbents or coprecipitation processes (**Deliverable for Year 3)**.